



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: **TAUBER et. al**

Application Serial No.: **10/785,510**

5 Application Filed: **February 17, 2004**

Attorney Docket No.: **CECOM 5522**

For: **RARE EARTH METAL COMPOUNDS FOR USE IN HIGH CRITICAL
TEMPERATURE THIN FILM SUPER-CONDUCTING ANTENNAS**

10 Sir:

These Remarks are submitted in support of amending the above-identified application.

REMARKS

15 Claims 48 and 80 are now in the case. Claims 1-47 and 49-79 have been canceled. No new claims have been added.

This Amendment responds to the first and non-final Office Action wherein the Examiner objected to claims 1-47 and 49-79 for being withdrawn instead of canceled and rejected both claims 48 and 80 as obvious under 35 U.S.C. § 103(a) based on the E.G. Fesenkō et al. article entitled "Synthesis And Investigation Of The Type $A_2Sb^{5+}O_6$ and $A_3Sb_2^{5+}B' O_9$ With Perovskite Structure," published in 1970 in view of Gallagher et al. U.S. Patent No. 4,962,086 entitled "High T_c Superconductor-Gallate Crystal Structures," issued on October 9, 1990.

25 Each objection, rejection and response is set forth in more detail below. The present Amendment cancels claims 1-47 and 49-79, clarifies the preambles of claims 48 and 80 to more particularly point out and distinctly claim this invention's high T_c superconducting Sr_2LuSbO_6 antennas and revises claims 48 and 80 to recite being heated at 1600 ° C for at least 20 hours in a way that is nonobvious over the prior art and overcomes and obviates the Examiner's objections and rejections, without adding any prohibited new matter. It is respectfully requested that the Examiner reconsider the objection and rejection and that claims 48 and 80, as amended, be allowed and pass to issue.

30 Before responding to the Examiner's prior art rejection, Applicants' attorney wishes to briefly describe the high T_c superconducting Sr_2LuSbO_6 antennae dielectric substrates and buffer

layers recited in amended claims 48 and 80. Claim 48, as amended, recites a high T_c superconducting antenna comprising a single layer of a copper oxide superconductor deposited onto a $\text{Sr}_2\text{LuSbO}_6$ single crystal substrate, with the substrate being heated at least 20 hours at 1600 ° C, constructed in bulk form, having an ordered perovskite cubic crystalline structure, a low dielectric constant of 15.1, a low dielectric loss of less than 1×10^{-3} without a phase transition, including an Sb^{5+} constituent atom with a polarizability of about 1.2 \AA^3 in the $\text{Sr}_2\text{LuSbO}_6$ formula and the copper oxide superconductor layer being patterned. Claim 80, recites a high T_c superconducting antenna device, comprising a single layer of a copper oxide superconductor onto a substrate with a buffered layer having the formula $\text{Sr}_2\text{LuSbO}_6$, being heated at least 20 hours at 1600 ° C, having an ordered perovskite cubic crystalline structure, a low dielectric constant of 15.1, a low dielectric loss of less than 1×10^{-3} without a phase transition, including an Sb^{5+} constituent atom with a polarizability of about 1.2 \AA^3 in the $\text{Sr}_2\text{LuSbO}_6$ formula and the copper oxide superconductor single layer being patterned. The specification describes the polarizability of the Sb^{5+} constituent atom from the $\text{Sr}_2\text{LuSbO}_6$ formula as being a significant feature that was neither taught nor disclosed by the prior art. It is respectfully submitted that the Fesenko and Gallagher '086 references, alone or in combination, fail to teach, suggest or disclose this invention's $\text{Sr}_2\text{LuSbO}_6$ antenna dielectric substrates and buffered layers, the polarizability of the Sb^{5+} atom and the advantageous dielectric constant and dielectric loss characteristics of those devices. Claims 48 and 80 were also clarified to recite being heated at 1600 ° C for at least 20 hours, which is adequately supported by specification page 6, lines 9-11. It is respectfully requested that the Examiner reconsider these obviousness rejections, and that the claims, as amended, be allowed and pass to issue.

The Examiner objected to claims 1-47 and 49-79 for being withdrawn instead of canceled, and the objection has been overcome and obviated by canceling those claims.

The Examiner rejected both claims as obvious under 35 U.S.C. § 103(a) based on the 1970 E.G. Fesenko et al. article entitled "Synthesis and Study of A₂Sb₅+O₆ and A₃Sb₂₅+B'O₉-type Ternary Oxides with Perovskite Structure," in view of Gallagher et al. U.S. Patent No. 4,962,086 entitled "High T_c Superconductor-Gallate Crystal Structures," issued on October 9, 1990. The Examiner stated that Gallagher '086 teaches a copper oxide layer deposited on a

single crystal substrate (COL. 10, lines 25-30) with the substrate having a low dielectric constant and losses (COL. 4, lines 27-34) and being favorable to use with high T_c superconductors (COL. 3, lines 35-40). However, the Examiner admitted that the patent is silent on using a substrate with the formula Sr_2LuSbO_6 . The Examiner stated that Fesenko teaches a cubic oxide substrate with the formula Sr_2LuSbO_6 (Table I) and a perovskite with Sb^{5+} ions occupying part of the octahedral position (Page 5). The Examiner also stated that the substrate is shown to be stable at high temperatures requiring two firings for its cubic structure and high phase change temperature (Page 4). According to the Examiner, since the substrate taught is the same as the claimed structure, it would be expected to possess the same intrinsic properties as those claimed. The Examiner concluded that it would have been obvious for the hypothetical skilled artisan to modify the Gallagher '086 compounds by substituting the Fesenko substrate because both are meant for high temperature superconductor applications and Fesenko is taught to be an effective substrate at high temperatures. These rejections are hereby traversed.

It is respectfully submitted that claims 48 and 80, as amended, are not obvious over the Fesenko and the Gallagher '086 references, either alone or in combination, because the Gallagher '086 patent does not teach a high T_c superconducting antenna with dielectric substrates and buffered layers having the formula Sr_2LuSbO_6 , both references fail to teach a number of this invention's crucial elements, particularly the polarizability of the Sb^{5+} atom and its ordered perovskite cubic crystalline structure and there are a number of other significant differences between the references and this invention in areas such as heat treatment intensity and length, density, lattice parameter, dielectric constant and dielectric loss. The substantial and patentably distinct differences between this invention and the prior art demonstrate that the claims, as amended, are not obvious over the references. It is respectfully requested that the Examiner reconsider these rejections and that claims 48 and 80, as amended, be allowed and pass to issue.

It is respectfully submitted that the Gallagher '086 patent does not teach or suggest this invention's Sr_2LuSbO_6 antennae dielectric substrates and buffered layers. Although the Examiner stated that Gallagher '086 taught a copper oxide layer deposited on a single crystal substrate (COL. 10, lines 25-30), the substrate having a low dielectric constant and losses (COL. 4, lines 27-34) and being favorable to use with high T_c superconductors (COL. 3, lines 35-40),

the Examiner admitted that the patent "...is silent as to the use of a substrate with the formula Sr₂LuSbO₆." In fact, the Gallagher '086 patent does not even mention Sr₂LuSbO₆. It is respectfully submitted that this invention is not obvious over the Gallagher '086 patent based upon its failure to teach, suggest or disclose the Sr₂LuSbO₆ formula. Not only does the patent 5 fail to mention the Sr₂LuSbO₆ formula, it teaches away from this invention by not disclosing crucial elements such as this invention's Sb⁵ atom, the polarizability of the Sb⁵⁺ atom, the ordered perovskite cubic crystalline structure and the advantageously low dielectric constant of 15.1 and dielectric loss of low dielectric loss of less than 1 x 10⁻³ without a phase transition.

After admitting that the Gallagher '086 patent "...is silent as to the use of a substrate with the formula Sr₂LuSbO₆," the Examiner maintained that the Fesenko reference teaches a cubic oxide substrate with the formula Sr₂LuSbO₆ (Table I), a perovskite with Sb⁵⁺ ions occupying part of the octahedral position (Page 5) and that the substrate is stable at high temperatures for its cubic structure and high phase change temperature (Page 4). According to the Examiner, it would have been obvious for the hypothetical skilled artisan to modify the Gallagher '086 15 compounds by substituting Fesenko's substrate because both are meant for high temperature superconductor applications and Fesenko taught an effective substrate at high temperatures.

It is respectfully submitted that this invention's Sr₂LuSbO₆ antenna dielectric substrates and buffered layers are not obvious over the combined Fesenko and Gallagher '086 references because they do not teach, suggest or disclose a number of this invention's crucial elements, particularly the Sb⁵⁺ atom having a polarizability of the about 1.2 Å³ and its ordered perovskite 20 cubic crystalline structure. Fesenko Page 5 discloses an Sb⁵⁺ ion, but the Fesenko article does not disclose the polarizability of the Sb⁵⁺ atom, as well as the relationship of the polarizability of the Sb⁵⁺ atom to key properties like this invention's advantageous and unexpected dielectric constant and dielectric loss characteristics.

Specification page 5, line 17 to page 6, line 5 describes the connection between this invention's high heat treatment requirements, material density and the Sb⁵⁺ constituent atom having a polarizability of 1.2 Å³, as follows:

It is important to note the significant relationship between the higher temperatures of 1400° C and 1600° C for 20-50 hours and the densities attained with these materials.

The papers "Dielectric constants of yttrium and rare-earth garnets, the polarizability of gallium oxide and the oxide additivity rule," by R.D. Shannon et al. and " Dielectric polarizabilities of ions in oxides and fluorides," by R.D. Shannon established that the dielectric constant of a well-behaved complex oxide can be predicted by knowing the
5 polarizability of the atoms making up the structure and the volume of the structure. From
these relationships it is straightforward to understand that the dielectric constant of a
material is sensitive to the sample's density. For instance, the more porous the sample
10 (i.e. less dense), the lower the dielectric constant will be (air has a dielectric constant of roughly 1.00 for a sample density approaching 0%). When comparing two samples of the same compound with equivalent densities, e.g. both 100 % dense, the same dielectric constant would be expected. However, when comparing two material samples with different densities and the same lattice parameter, the dielectric constant measurements can be appreciably different, again dependent on the difference in sample density.

15 Further, the polarizability of Sb⁵⁺, which is a constituent atom of the materials used to fabricate the compounds and devices of the present invention, has not been previously known. The materials of the present invention all include at least one Sb⁵⁺ constituent atom with a polarizability of about 1.2 Å³. Therefore, prior art references that do not account for significant factors such as polarizability and material density have not predicted the advantageous dielectric constants of the materials of the present invention.

20 (Emphasis Supplied)

Thus, there is a significant relationship between this invention's higher temperature of 1600° C for at least 20 hours, the material's density, the dielectric constant being sensitive to the material's density and the polarizability of the Sb⁵⁺ atom, and this relationship has not been shown in the prior art before. Further, the polarizability of the Sb⁺⁵ constituent atom has previously been considered a patentably significant difference between the prior art and the claims in another patent application filed by the inventors herein and other co-inventors. During the prosecution of U.S. Patent Application No. 09/371,166 for a dielectric substrate with the general formula A₄MeSb₃O₁₂, which resulted in U.S. Patent No. 6,084,246, the Examiner's Reasons For Allowance in the first Office Action dated February 14, 2000, Paper No. 5, page 5

stated:

The prior art does not disclose the limitations of these claims, particularly $A_4MeSb_3O_{12}$ compound with an Sb^{+5} constituent atom having a polarizability of about 1.2 \AA^3

Therefore, neither the Fesenko nor Gallagher '086 references teach, suggest or disclose the 1.2 \AA^3 polarizability of the Sb^{+5} atom and the relationship of the polarizability of the Sb^{+5} atom to important properties such as the unexpected dielectric constant and dielectric loss characteristics of this invention's antenna dielectric substrates and buffered layers.

The references fail to teach, suggest or disclose this invention's ordered perovskite cubic crystalline structure. Fesenko Page 3 discloses a 4.07 lattice parameter, and based upon that table, the Fesenko reference, as best understood, discloses compounds that are not ordered. By contrast, this invention's Sr_2LuSbO_6 antenna dielectric substrates and buffered layers exhibit an ordered perovskite cubic crystalline structure. Specification page 3, lines 13-15 discloses the crystalline structure for this invention's Sr_2LuSbO_6 antenna dielectric substrates and buffer layers, as follows:

Indexed powder diffractometer data taken using $CuK\alpha$ radiation, reveals these compounds to be ordered perovskites. With the exceptions of Sr_2LuSbO_6 and Sr_2LaSbO_6 that are cubic, all of the other compounds are found to be pseudo-cubic, tetragonal.

(Emphasis Supplied)

Specification page 6, lines 9-14 also discloses the connection between this invention's ordered perovskite cubic crystalline structure and its intense heat treatment requirements, as follows:

We have discovered that in order to achieve an ordered cubic single phase material, sintering at $1600^\circ C$ for at least 20 hours in the case of Sr_2LuSbO_6 and $1400^\circ C$ for Sr_2LaSbO_6 for at least 20 hours were essential. It is also noted that the cubic ordered perovskites prepared in connection with the present invention are quite different from those found in the literature because the compounds disclosed herein were prepared at higher temperatures for a longer period of time.

(Emphasis Supplied)

The Fesenko article does not teach, suggest or disclose this invention's ordered perovskite cubic crystalline structure. It is respectfully submitted that the Fesenko and Gallagher '086 references, alone or in combination, do not teach, suggest or disclose this invention's Sr_2LuSbO_6 dielectric

substrates and buffered layers formula including the Sb⁵⁺ constituent atom with a polarizability of about 1.2 Å³ and this invention's ordered perovskite cubic crystalline structure.

It is further respectfully submitted that the claims, as amended, are not obvious over the references, either alone or in combination, because they do not teach a number of other 5 patentably distinct differences such as intensity of heat treatment, length of heat treatment, density, lattice parameter, dielectric constant and dielectric loss.

The Fesenko paper discloses a lower heating requirement than this invention's Sr₂LuSbO₆ antenna dielectric substrates and buffered layers, and these heating differences could cause the Fesenko materials to exhibit less advantageous properties. Specification page 6, lines 10 9-11 disclose that this invention's Sr₂LuSbO₆ antenna dielectric substrates and buffered layers are heated for at least 20 hours at 1600° C. As discussed more fully in the specification page 5, line 17 passage quoted above, there is a "significant relationship between the higher temperatures of 1400° C and 1600° C for 20-50 hours and the densities attained..." By contrast, Fesenko Page 1, unnumbered fourth paragraph teaches a two stage heating process: 1100° C for 10 hours and 15 1400° C for three (3) hours. Based upon the substantially lower temperature range of 1100° C to 1400° C as compared to this invention's 1600° C heating requirement, it is respectfully submitted that the Fesenko materials will not achieve this invention's advantageous density, dielectric constant and dielectric loss properties.

Similarly, because the Fesenko paper discloses a substantially shorter total heating time 20 of 13 hours, as compared to this invention's heating time of at least 20 hours, with specification page 5, lines 17-18 disclosing a preference for 20-50 hours, it is respectfully submitted that the Fesenko materials will not achieve this invention's advantageous density, dielectric constant and dielectric loss properties. The link between this invention's substantially longer high temperature heating time and crystal structure quoted above at specification page 5, lines 17-19 and 25 specification page 6, lines 6-14, is also a patentably distinct difference between this invention and the references.

It is respectfully submitted that the references do not teach, suggest or disclose that their materials exhibit any particular density, and since the Fesenko and Gallagher '086 materials seem to have been prepared at lower heating temperatures for a shorter duration, it is respectfully

submitted that the references do not teach, disclose or suggest this invention's denser Sr₂LuSbO₆ antenna dielectric substrates and buffered layers.

Another significant difference between this invention's Sr₂LuSbO₆ antenna dielectric substrates and buffered layers and the Fesenko materials is this invention's significantly higher 5 lattice parameter. Table I of the specification discloses an 8.188 lattice parameter, while the Fesenko Page 3 Table discloses a 4.07 lattice parameter.

It is further respectfully submitted that this invention's Sr₂LuSbO₆ antenna dielectric substrates and buffered layers are not obvious over the references because they do not teach, suggest or disclose this invention's advantageous low dielectric constant of 15.1 and a low 10 dielectric loss of less than 1×10^{-3} without a phase transition. The Fesenko article, as best understood, does not teach or disclose any particular dielectric constant or dielectric loss for its Sr₂LuSbO₆ compound. As admitted by the Examiner, the Gallagher '086 patent does not teach, disclose or suggest this invention's Sr₂LuSbO₆ formula. However, COL. 3, lines 35-40 discloses an unspecified low dielectric constant and dielectric loss and COL. 10, lines 15-17 discloses a 15 higher dielectric constant of 25 for a YBa₂Cu₃O_x film epitaxially deposited on an LaGaO₃ crystal wafer. Clearly, even if one overlooks the failure to teach this invention's Sr₂LuSbO₆ formula, the Gallagher '086 dielectric constant of 25 is much higher than this invention's low dielectric constant of 15.1. Therefore, it is respectfully submitted that the claims 48 and 80, as amended, are not obvious over the references, either alone or in combination, because there are a number of 20 significant differences between the references and this invention in areas such as heat treatment intensity and length, density, lattice parameter, dielectric constant and dielectric loss.

For these reasons, it is further respectfully submitted that this invention's Sr₂LuSbO₆ antennae dielectric substrates and buffered layers are not obvious over the Fesenko and the Gallagher '086 references, either alone or in combination, because the Gallagher '086 patent 25 does not teach a high T_c superconducting antenna with dielectric substrates and buffered layers having the formula Sr₂LuSbO₆, both references fail to teach a number of this invention's crucial elements, particularly the polarizability of the Sb⁵⁺ atom and its ordered perovskite cubic crystalline structure and there are a number of other significant patentably distinct differences between the references and this invention in areas such as heat treatment intensity and length,

density, lattice parameter, dielectric constant and dielectric loss. It is respectfully requested that the Examiner reconsider these objections and rejections and that claims 48 and 80, as amended, be allowed and pass to issue.

Should the Examiner require further information, the Examiner is invited to telephone the
5 applicants' attorney at the telephone number listed below.

Respectfully Submitted,



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DATE

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